leXsolar-ThermalEnergy Professional

Instructions manual

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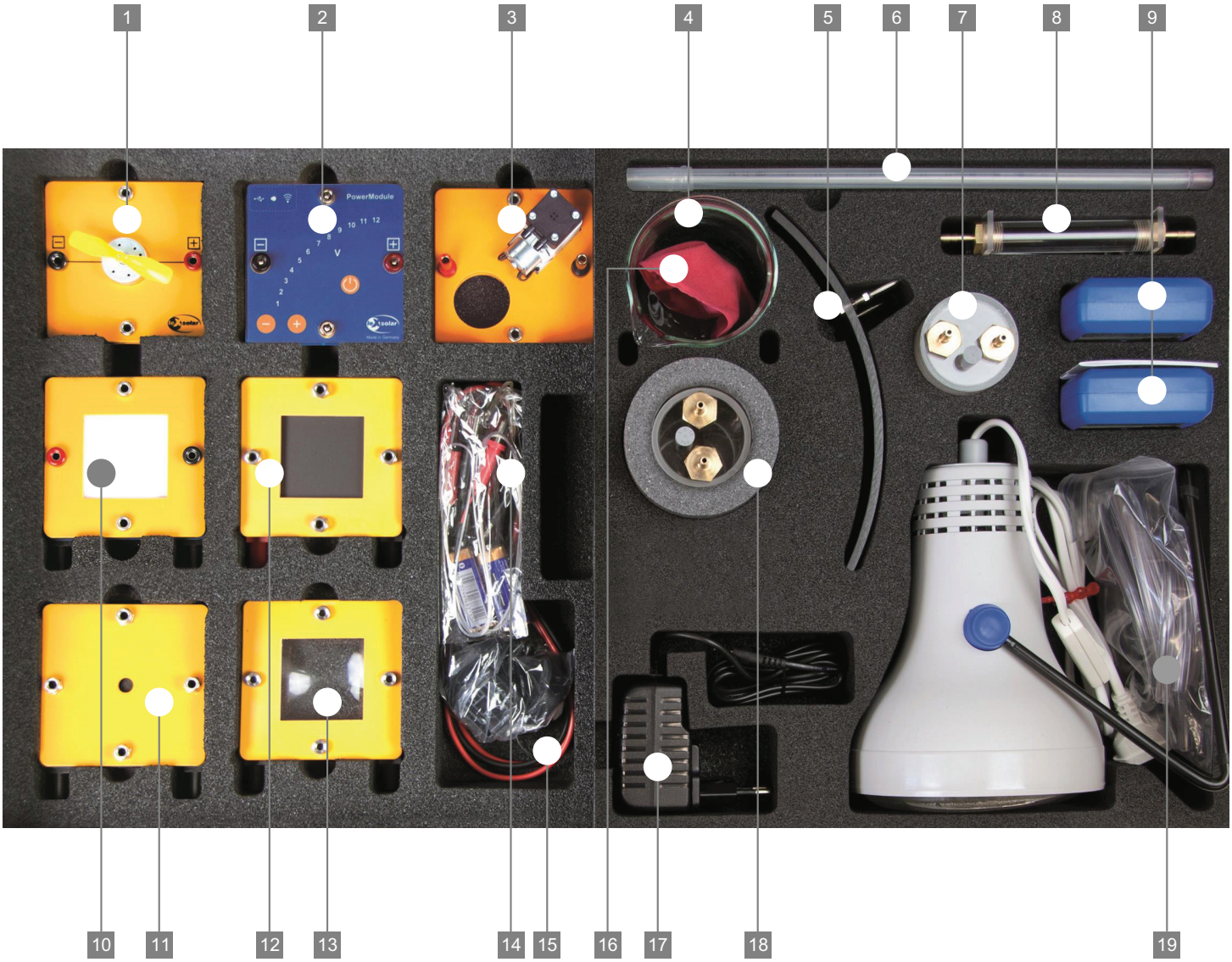
Layout diagram leXsolar-ThermalEnergy Professional

Item-No.1306

Bestückungsplan leXsolar-ThermalEnergy Professional

Art.-Nr.1306



1 1100-27 Motor module without gear
1100-27 Motormodul ohne Getriebe
L2-02-017 Propeller
L2-02-017 Propeller

2 9100-05 PowerModul with 17
9100-05 PowerModul mit 17

3 1300-09 Pump module with 23
1300-09 Pumpenmodul mit 23

4 L2-06-082 Beaker 250 ml
L2-06-082 Becherglas 250 ml

5 1300-04 Parabolic reflector
1300-04 Parabolspiegel-Kollektor

6 L2-06-016 Laboratory thermometer
L2-06-016 Laborthermometer

7 1300-12 Heat exchanger paraffin
1300-12 Wärmetauscher Paraffin

8 1300-05 Absorber tube
1300-05 Absorberrohr

9 2xL2-06-011 Digital multimeter
2xL2-06-011 Digitalmultimeter

10 1300-08 Absorber B/W
1300-08 Absorber S/W

11 1300-07 Absorber module for lens
1300-07 Absorbermodul für Linse

12 1300-10 Peltier module
1300-10 Peltiermodul

13 1300-06 Lens module
1300-06 Linsenmodul

14 L2-06-123 Temperature measuring sensor
L2-06-123 Temperaturmesssensor

15 2xL2-06-059/060 Test leads red/black
2xL2-06-059/060 Messleitung rot/schwarz

16 L2-06-125 Cooling pad
L2-06-125 Kühlkissen

17 Power supply for 2
Stromversorgung für 2

18 1300-11 Heat exchanger water
1300-11 Wärmetauscher Wasser

19 1300-13 Hose set
1300-13 Schläuche-Set

Version number
Versionsnummer

II-01.24_L3-03-190_14.06.2017

CE RoHS2

Layout diagram leXsolar-ThermalEnergy Professional

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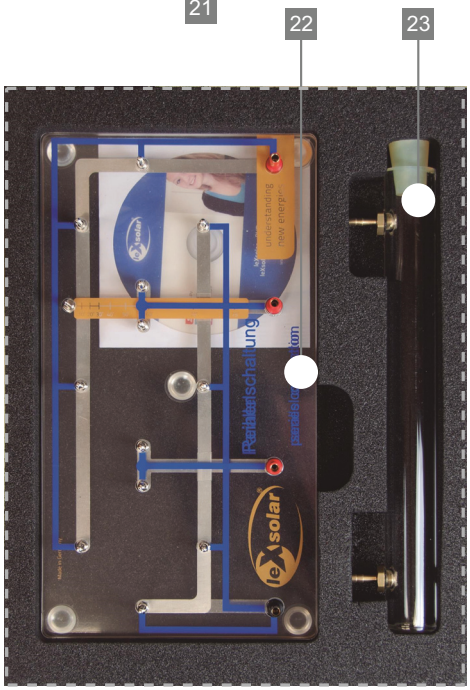


20 1300-03 Solar colector
1300-03 Solar-Kollektor

21 L2-04-116 Illuminant 120W with
L2-04-080 Lamp housing
L2-04-116 Leuchtmittel 120W mit
L2-04-080 Lampengehäuse

22 1100-19 leXsolar-basic unit
1100-19 Grundeinheit groß

23 Balancing container with 3
Ausgleichsgefäß mit 3

CE RoHS2

leXsolar-ThermalEnergy Professional

Instructions manual

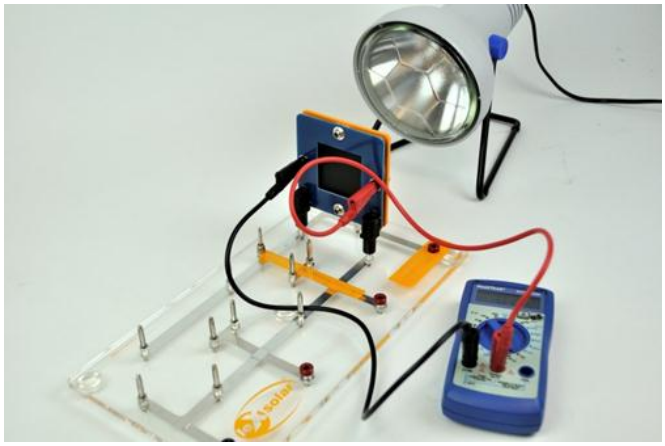
Content

1. Absorptivity and reflectivity of different materials

Task

Find out the differences in absorptivity and reflectivity of thermal radiation for a copper plate with white and black coating.

Setup



Equipment

-Basic module
-Spotlight
-Digital meter
-Absorption module black/white
-Cables

Procedure

1. Put the absorption module black/white into the basic module with the white side facing the spotlight. The distance between absorption module and spotlight should be 15 cm.
2. Connect the digital meter with the absorption module black/white as shown in the figure.
3. Adjust the digital meter to the symbol °C to start the temperature measurement. Also keep a clock ready for time measurements during the experiment.
4. Note down the temperature T(0) at the beginning and start the measurement by turning on the spotlight. Write down the temperature, which is measured electrically on the metal surface, every minute.
5. Turn the spotlight off and let the absorption module black/white cool down until it has returned to its approximate starting temperature.
6. Repeat the measurement with the black side of the absorption module. Take care that the distance to the spotlight is again 15 cm.

Data

Table 1.1 – Development of the temperature on the white side

Time in minutes	0	1	2	3	4	5	6	…
Temperature								

1. Absorption and reflectivity of different materials

Data

Table 2.1 – Development of the temperature on the black side

Time in minutes	0	1	2	3	4	5	6	…
Temperature								

Analysis

1. Enter your results in the depicted diagram.
2. Compare the results of the two parts of the experiment and explain the observed differences.
3. Explain which conclusions can be drawn from your results for the construction of solar thermal collectors.

Diagram

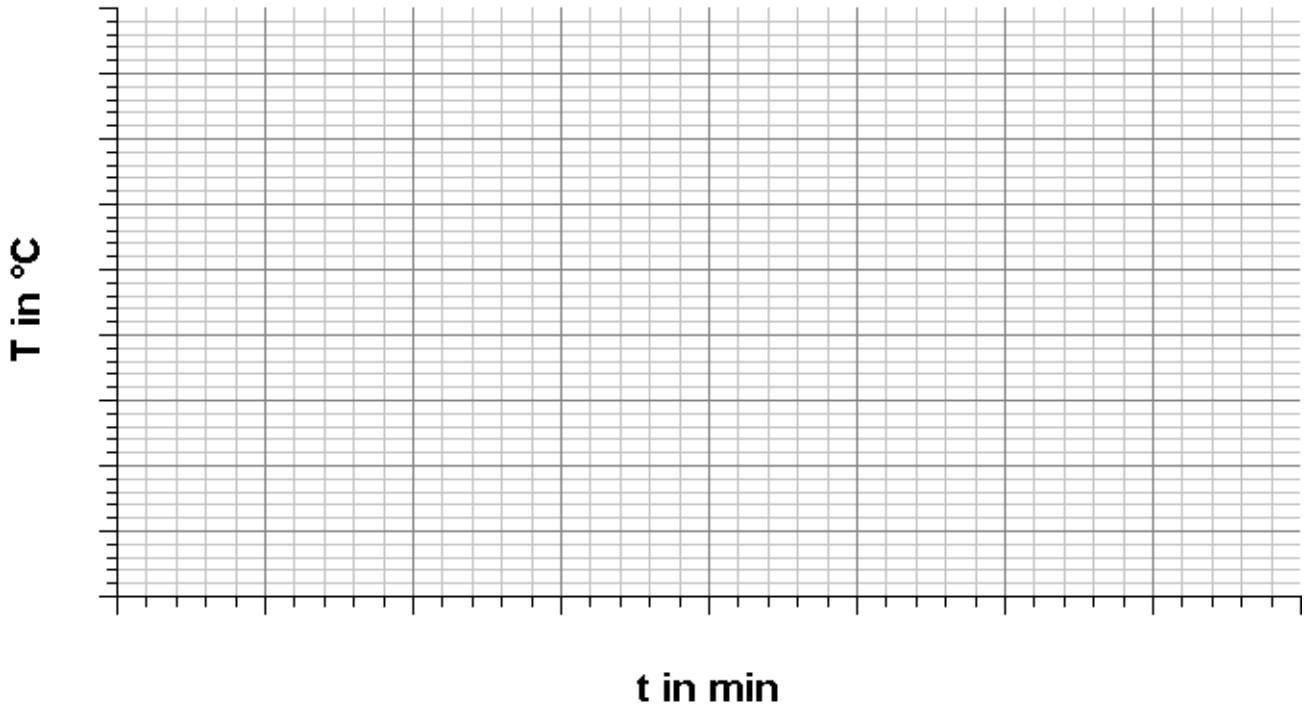


Diagram 1.1 – Development of the temperature at the absorption module black/white.

1. Absorptivity and reflectivity of different materials

Analysis

2.

3.

2. Focusing of light by a Fresnel lens

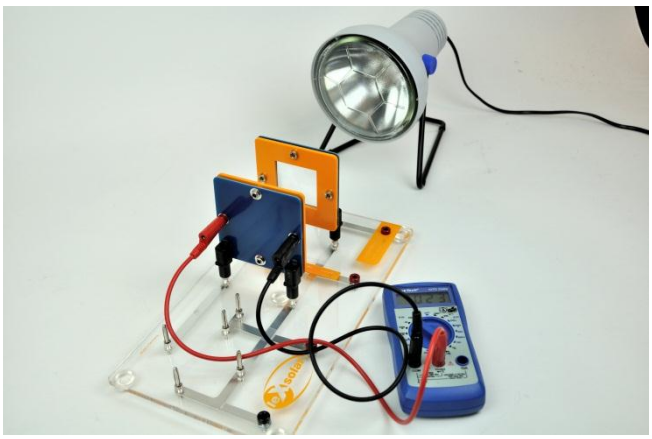
Task

Demonstrate the influence of the focusing of sunlight on the heating of an absorber material.

Setup

2.1 Heating without Fresnel lens

2.2 Heating with Fresnel lens



Equipment

- Basic module
- Spotlight
- Digital meter
- Lens module
- Lens absorption module
- Cables

Procedure

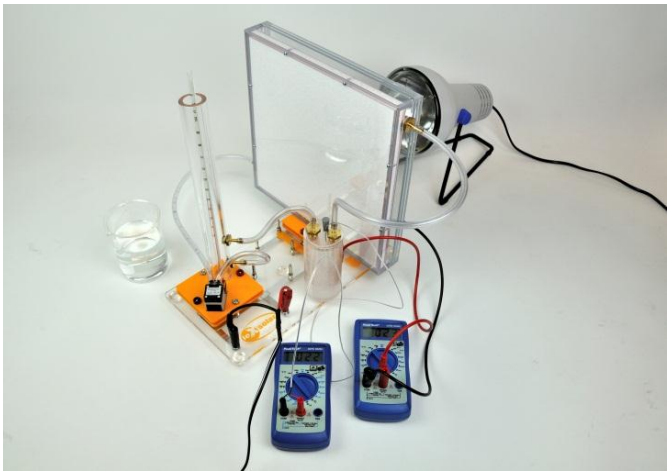
1. Put the lens absorption module into the basic module with the opening facing the spotlight. Adjust the distance to the spotlight to approx. 25 cm.
2. Then connect the digital meter with the lens absorption module as shown in figure 2.1.
3. Adjust the digital meter to the symbol °C to start the temperature measurement. Also keep a clock ready for time measurements during the experiment.
4. Note down the temperature T(0) at the beginning and start the measurement by turning on the spotlight. Write down the temperature, which is measured electrically on the metal surface, every minute.
5. Turn the spotlight off and let the lens absorption module cool down until it has returned to its approximate starting temperature.
6. Now put the lens module between the spotlight and the absorber as shown in figure 2. Take care that the distance to the spotlight is again 15 cm.
7. Note down the temperature T(0) at the beginning and start the measurement by turning on the spotlight. Write down the temperature, which is measured electrically on the metal surface, every minute.

10. Collector circuit with paraffin heat reservoir

Task

Show that thermal energy can be stored in the transition from solid to liquid state by means of paraffin wax heat reservoir.

Setup



Equipment

- Basic module
- Pump module
- Balancing container
- Solar collector
- Hoses
- 2x digital meter with cables
- Temperature probes
- Liquid thermometer
- Spotlight
- PowerModule
- Heat storage module
- Cork

Procedure

1. Place the solar collector and the pump module with the balancing container onto the basic module and connect the modules with the enclosed hoses.

   Advice: It must be ensured that the left pump module connection is plugged into the lower connection of the collector and the right connection is plugged into the balancing container. Place the heat storage module between the upper connection of the collector and the balancing container to close the water circuit.

2. Fill the balancing container with water and connect the PowerModule to the pump (9V). This pumps water into the circuit.

   Advice: If necessary, refill the beaker with water until a stable water circuit with 200ml is reached. Swing the collector carefully to remove residual water bubbles from the collector.

3. Connect the probe of the digital meter to the paraffin wax container and close the opening with the cork. Pay attention that the measurement probe does not touch the copper block and is positioned at the centre of the heat exchanger. Take a stopwatch to measure the time.
4. Adjust the digital meters to “°C” to start the measurement. Connect the temperature probe with one device. Connect the other meter with two cables directly to the collector, which has an internal temperature sensor. Place the spotlight 15 cm away from the collector and switch it on.
5. Measure the temperature gradient at all positions simultaneously and write the corresponding values into the table.

10. Collector circuit with paraffin heat reservoir

Procedure

6. Turn off the collector after 80 minutes and observe the temperature gradient. To speed up the experiment, it is possible to use warm water from the tap at the beginning.

Data

Time in minutes	Temperature collector in C°	Temperature heat storage in C°	Temperature balancing container in C°
0			
2			
4			
6			
8			
10			
12			
14			
16			
18			
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10. Collector circuit with paraffin heat reservoir

Data

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120			

Analysis

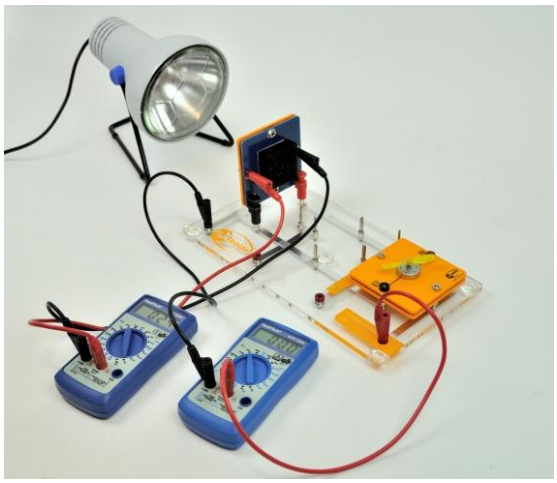
1. Record your results in the pictured diagram.
2. Compare the results at different measuring positions. Comment on your observations during the cooling of the system.
3. Explain the observations you made at the heat storage with the aid of your knowledge about aggregate state transitions.
4. Calculate the amount of energy that can be stored in 0.1dm³ water and 01dm³ paraffin wax respectively, if it is heated from 20°C to 60°C. In this temperature range, the melting point of paraffin wax is exceeded. Discuss the results and conclude possible applications for a paraffin wax heat storage.
   (Density: $\rho_{water} = 1000\frac{kg}{m^3}$, $\rho_{paraffin} = 800\frac{kg}{m^3}$, specific heat capacitance: $c_{water} = 4.18\frac{kJ}{kgK}$, $c_{paraffin} = 2.89\frac{kJ}{kgK}$, Specific melting heat: $h_{paraffin} = 220\frac{kJ}{kg}$)

15. Quantitative determination of the electrical power

Task

Show quantitatively that, by heating one side of the Peltier element, a voltage is generated, which can be used to operate a small electrical consumer.

Setup



Equipment

- Basic module
- Peltier module
- 2x digital meter
- Cables
- Spotlight
- Motor module

Procedure

1. Place the Peltier module onto the basic module as shown.
2. Furthermore, connect both digital meters to the basic module and the Peltier module as depicted.

   Advice: The digital meter at the Peltier module is used to measure the temperature. Voltage and current are measured with the second digital meter.

3. Place the spotlight 15 cm away from the Peltier element and start the measurement.
4. Observe the development of temperature, voltage and current and write your data into the table.

Data

Time in minutes	Current in mA	Voltage in mV	Power in mW	Temperature Peltier element in °C

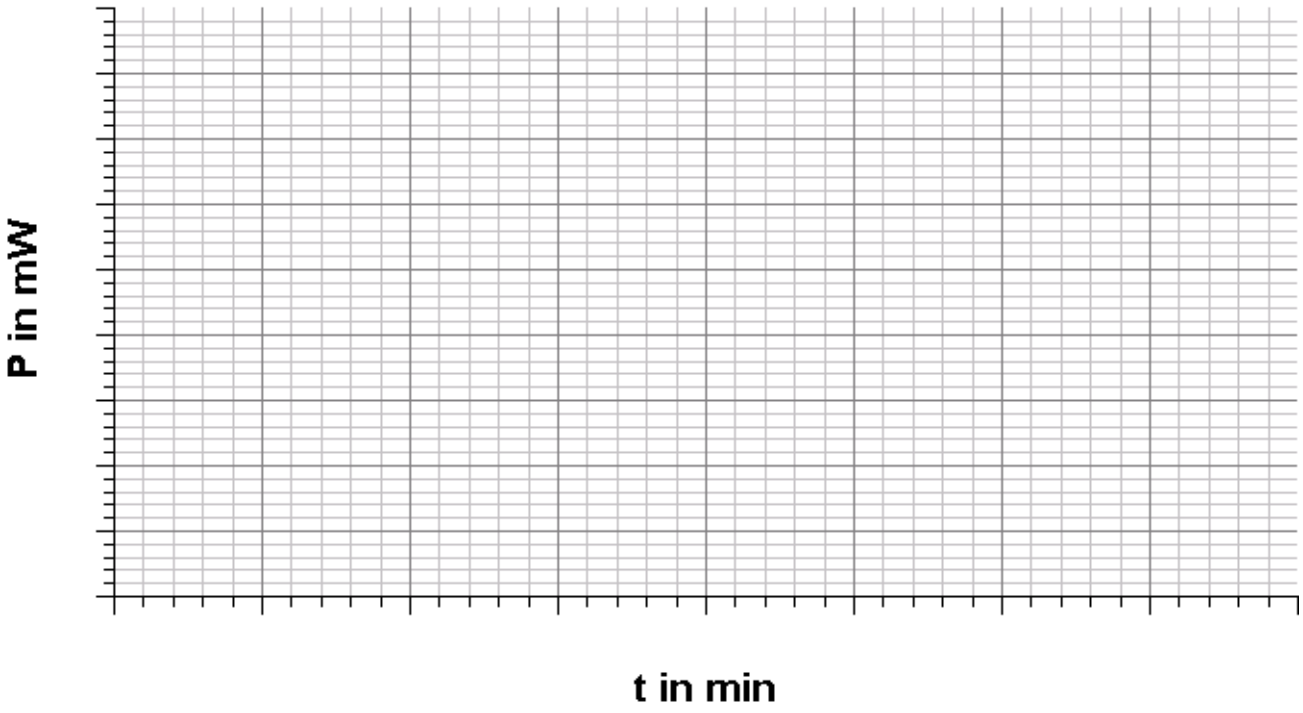
15. Quantitative determination of the electrical power

Data

Analysis

1. Calculate the power for each data row and write the result into the respective column.
2. Enter your results in the depicted diagram.
3. Estimate the permanent power of the thermoelectric generator by using the measurement data and calculate the power conversion efficiency of the measurement setup.
4. Name a few possible applications where the thermoelectric generator can be used even though its power conversion efficiency is low.

Diagram



15. Quantitative determination of the electrical power

Analysis

3.

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